

PHILOSOPHICAL
TRANSACTIONS.

VIII. *On the Rate of Travelling, as performed by Camels; and its Application, as a Scale, to the Purposes of Geography.* By James Rennell, Esq. F. R. S.

Read March 17, 1791.

AMONGST the discoveries and improvements of various kinds, that may be expected from the very laudable, and, as it concerns mankind in the gross, no less humane and benevolent institution of AN ASSOCIATION FOR PROMOTING DISCOVERIES IN THE INTERIOR PARTS OF AFRICA, that of the geography of the Continent in question may be expected to make the quickest progress: since, in every kind of distant research, whether successful or otherwise, the act of enquiry alone brings materials to the geographer. But, even with every
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ordinary advantage, the geography of a continent must necessarily be slow in its progress towards maturity; *we*, therefore, can only expect to witness its early infancy; and cannot, from a view of the present, allow ourselves to predict what its future features may be. Let it be our care, however, to foster it; and contribute all within our power towards its improvement and perfection.

In a case where there is so little probability, even in a long course of time, of obtaining many fixed points by celestial observations (though I hope that one at least will be attempted in the central part of Africa, in our time), it is fortunate that the mode of travelling happens to be such, as serves to furnish a remarkably equal scale: the rate of the camel's movement appearing to be, beyond all others, the least variable; whether we examine it by portions of days, or of hours. In the present state of things, the former mode alone can be used; because few or none of the African travellers carry watches with them: but it may be hoped, that at no very distant period, the time employed on the road may be obtained with such a degree of exactness, as to furnish the geographer with materials of a far better kind, than any of those, formed on computation, that have hitherto been exhibited.

These remarks occurred on the result of an examination, which (though for a different purpose) I lately made into the rate of the camel's movement on the Arabian desert, between Aleppo, Bagdad, and Bussorah: for it appeared to me, that if the African caravans are composed of the same kind of camels, and are governed in their motions and œconomy by the same circumstances, as those which cross the Arabian deserts; there is no scale, of the computed kind, that can be more applicable to the African geography, than that formed on the camel's rate
of

of travelling. I shall therefore detail the examples from whence I have drawn the proportions for the hours and days journey of the camel, under the two different degrees of burthen, which constitute what is commonly denominated the LIGHT, and the HEAVY caravan.

The routes which furnish the above examples are determined in their horizontal, or direct distance, by the respective positions of ALEPPO, BAGDAD, and BUSSORAH: all of which have their latitudes and longitudes fixed by celestial observations *. These routes are five in number: and although some of the journals that describe them, contain less information than others, yet all of them have the time given with a sufficient degree of precision, to enable me to found a general rule on. Three of these routes lead across the GREAT DESERT, or that between Aleppo and Bufforah; the other two are across the LITTLE DESERT, or that between Aleppo and Bagdad.

The first of the Great Desert routes was traced by a Mr. CAR-MICHAEL in 1751. The manuscript copy of his Journal was obligingly communicated by my friend Dr. PATRICK RUSSELL; and it manifests a great degree of ingenuity and perseverance in this way. The Author declares, that he was determined to keep a register of the courses by a compass, and to compute, comparatively, if not absolutely, the intermediate distance on each course; by counting the steps or paces of the camel on which he rode, during a certain interval of time; and afterwards measuring a number of them on the ground. The particulars of this operation shall be given hereafter; and

* Aleppo, in Conn. des Temps, lat. $36^{\circ} 11'$, long. $37^{\circ} 9'$, reckoned from Greenwich.

Bagdad, by M. BEAUCHAMP, lat. $33^{\circ} 22'$, long. $44^{\circ} 21'$, Greenwich.

Bufforah, by Capt. RITCHIE, lat. $30^{\circ} 30'$, long. $47^{\circ} 33'$, Greenwich.

although Mr. CARMICHAEL failed in the attempt to ascertain his road distance by this method, yet his process has furnished others with the means of ascertaining the whole distance in the aggregate, and of proportioning the parts throughout. For, as the direct distance is given by the celestial observations, and a complete traverse table by the journal, the *data* are perfect. And when the reader is informed that Mr. CARMICHAEL's whole line of bearing, *by compass*, between Aleppo and Bufforah, nearly 720 British miles, coincided with the bearing line given by the celestial observations; by which it appears that the error could amount only to the mean quantity of the variation throughout, which might have been from six to seven degrees at that time (1751); he will give Mr. CARMICHAEL credit for much general accuracy. And it is not improbable, that even a considerable portion of the above error may have arisen from the imperfection of his instrument *.

The second journal was kept by Colonel CAPPER, in 1778, and was published several years ago; and the third, which contains little more than the time in detail, was communicated by my friend Mr. HUNTER, who crossed the desert in 1767.

The time given between Aleppo and Bufforah, by these journals respectively, is as follows:

By Mr. CARMICHAEL	.	322 hours.
Colonel CAPPER	.	310
Mr. HUNTER	.	299½

* I find, by Mr. DRUMMOND's chart of the road between Aleppo and Antioch (1747), that the variation was then about 6 degrees westerly. This is proved by comparing his magnetic bearing line between those places, with that given by the difference of latitude. In the head of the Gulf of Persia, the variation was 7 degrees in 1785.

But

But to shew that this difference arose chiefly from the variations in the route across the CHALDEAN DESERT (between Mesjid Ali and Bussorah; see the annexed sketch, Tab. III.), I shall proceed, first, to explain that part of the subject; and afterwards to exhibit the particulars in proof.

Mesjid Ali (or Ali's Mosque) is situated at about two thirds of the distance, and as nearly as possible in the line of direction, between Aleppo and Bussorah; and is a sort of land-mark to the caravans which pass the common boundary of the Arabian and Chaldean deserts. Its geographical position is deduced from bearings and latitudes taken by M. NIEBUHR and others: and therefore, as far as general geography is concerned, it may almost be regarded as a fixed point. Not that the truth of its position will in any shape affect the present head of enquiry; which is entirely directed towards a comparison of the spaces of time, employed between certain points of the route, by each traveller respectively.

Now, that portion of the Desert route between Mesjid Ali and Bussorah, being subject to great variation in the track, as appears by the journals of different travellers; whilst the much larger portion of it, between Mesjid Ali and Aleppo, is very nearly the same at all times; it is very clear, that this latter portion furnishes the properest ground on which to form the comparison: and the particulars are as follow:

	CARMICHUEL.	CAPPER.	HUNTER.	
	H. M.	H. M.	H. M.	
Aleppo to Hagla .	11 5	11 24	10 0	Hagla.
Hagla to Ain il Koom .	37 30	41 4	35 0	to Taiba. to Uklet Hauran.
Ain il Koom to Uklet Hauran.	80 10	78 41	81 30	
Hagla to Uklet Hauran .	117 40	119 45	116 30	
Uklet Hauran to Al Kadder	53 50	54 45	51 30	
Hagla to Al Kadder .	171 30	174 30	168 0	
Al Kadder to Rackama, opposite Mesjid Ali .	21 45	19 50	19 30	
Hagla to Rackama .	193 15	194 20	187 30	
Aleppo to Rackama .	204 20	205 44	197 30	

On the Little Defert I have two examples of time, from Mr. IRWIN in 1781, and Mr. HOLFORD in 1780; both of whom kept regular journals.

	IRWIN.	HOLFORD.
	H. M.	H. M.
Aleppo to Ain il Koom.	52 0	46 27
Ain il Koom to Annah on the Euphrates	76 0	80 15
Aleppo to Annah	128 0	126 42

It appears by the journals, that Mr. IRWIN deviated from the usual track in the first part of his route; and that Mr. HOLFORD did the like in the latter part of his; each to avoid an enemy: so that it may be presumed, that the deviations nearly balanced each other (see the sketch).

Between Annah and Bagdad, these gentlemen made part of their journey in the caravan of loaded camels, and partly with *light* camels (that is, without any other load than the rider). Mr. IRWIN employed $62\frac{1}{2}$ hours: but the last 15 hours, on *light*

light camels, were at an accelerated rate of half a mile *per* hour, or one fifth part, above the ordinary rate; according to his idea, which I have no doubt was a very just one: and this accelerated rate should add 3 hours to the 15, to reduce it to caravan time; making $65\frac{1}{2}$ hours instead of $62\frac{1}{2}$. Mr. HOLFORD's journey, by the same *ratio*, must be reckoned at 68: but as this part of the two journies is obviously too inaccurate to draw any conclusions from, in the way of comparison, I shall only make use of Mr. IRWIN's time (to which no solid objection can be urged) when I calculate the rate of the camel's travelling.

We have now seen, that on a journey of about 200 hours, between Aleppo and Mesjid Ali, two accounts differ only 1 hour 24 minutes; and a third differs from the mean of the other two seven hours and an half. And we may observe, that if the stage from Aleppo to Hagla be taken out of the question, the number of Mr. HUNTER's hours would be nearer on an equality with the others by about an hour and a quarter (see p. 134.). The reason of the different reports of the distance between Aleppo and Hagla, appears to be, that travellers commonly join the caravans either at Hagla or on the road to it; and they, travelling by a quicker conveyance than camels afford, and then adjusting the time to the caravan rate, make different estimates of the distance. Or there may be some other cause which has not been explained. Four different persons give the time as follows:

	H.	M.		H.	M.
CARMICHAEL	11	5	CAPPER	11	24
HUNTER	10	0	HOLFORD	9	12

So that the proper point of outset in making the comparison,
is

is Hagla. And, reckoning from thence, we have in the first table (p. 134.) the numbers $193\frac{1}{4}$, $194\frac{1}{2}$, and $187\frac{1}{2}$, for the time between Hagla and Mesjid Ali, in the three journies respectively: and the same table affords also the following comparisons between different places on the route:

In one instance, $80\frac{1}{6}$, and $78\frac{2}{3}$;

In a second, . $117\frac{2}{3}$, $119\frac{3}{4}$, and $116\frac{1}{2}$;

In a third, . $53\frac{3}{4}$, $54\frac{3}{4}$, and $51\frac{1}{2}$;

And in a fourth, $171\frac{1}{2}$, $174\frac{1}{2}$, and 168.

Again, between Aleppo and Annah on the Euphrates, the numbers in the second table stand thus:

128, and $126\frac{2}{3}$.

I think I need not produce any more examples to prove the equal rate of motion of a camel that is in any degree loaded; or rather of a number of camels together, where the rate will be determined by the *slow-going ones*: and whatsoever rate, in actual distance, may be deduced from these examples, must be applied to loaded camels travelling in a body together, and not to light camels, or those chosen for speed, whose rate appears to be at least $\frac{1}{3}$ th greater. By a light camel is meant one that has only a man, or a very small quantity of baggage, on it; whereas a camel's load is 500 to 600 pounds; and camels so loaded, form what is termed the **HEAVY** caravan. **LIGHT** caravan, on the contrary, is applied to camels under a *moderate* load, or perhaps little more than half loaded. And with respect to camels, either *moderately* or *fully loaded*, I can perceive no difference in their hourly rate of motion: the difference alone appears in the length of their day's journey; as we shall perceive hereafter. A camel, it is said, will not permit himself to be over-laden; and this may be the reason why the load does not affect his rate of motion.

It

It appears, that the direct distance between Aleppo and Bufforah, is 621 geographic miles, or 720 British, nearly. And Mr. CARMICHAEL's route, traced by a compass through all its principal bendings, and calculated trigonometrically, gives 688 geographic miles, or of British 797. It follows then, of course, that as the same gentleman was 322 hours on the road, the mean hourly rate of the camel's motion, was 2,475 British miles. Colonel CAPPER's route, though easily traced on the map, is not correct enough in its particulars, to serve as an authority equal to Mr. CARMICHAEL's; and the like may be said of Mr. HUNTER's: but they must both be allowed to corroborate Mr. CARMICHAEL's in a general way; for as nearly as Colonel CAPPER's route can be traced, over the CHALDEAN Desert (and, as we have before observed, the track is nearly the same at all times, in all other parts of the Desert) the hourly rate of his camels was 2,51 *per* hour; and that of Mr. HUNTER's 2,585.

We come now to the LITTLE DESERT route. It has been noticed, that Mr. IRWIN employed 128 hours on his journey from Aleppo to Annah; and $65\frac{1}{2}$ more (allowing for his accelerated rate 3 hours, see p. 135.) between Annah and Bagdad; altogether $193\frac{1}{2}$ hours between Aleppo and Bagdad. The direct distance between those places is 393 geographic miles; and by the route traced by Mr. IRWIN, the *road distance* comes out about $414\frac{1}{2}$, or British miles 480 *. And this number, divided by $193\frac{1}{2}$, gives 2,48 *per* hour for the camel's rate; or

* Not that the distance between those places is so much as 480 miles by the direct road: it is probably less than 470. But Mr. IRWIN's party took a circuitous course to the southward, between Aleppo and Ain il Koom, to avoid an enemy that lay in the way. He estimated his distance at 493 miles.

within a very small fraction of Mr. CARMICHAEL's rate; his being, as we have just seen, 2,475.

I think I may venture to rest the calculation of the loaded camel's mean hourly rate of travelling, on the experiments of Mr. CARMICHAEL and of Mr. IRWIN; both of whom appear to have taken much pains with the detail of their journies*; and then it will stand as under:

Mr. CARMICHAEL on 322 hours 2,475 } Mean 2,478 Bri-
Mr. IRWIN on 193½ . . . 2,48 } tish miles.

We have mentioned above, the result of Colonel CAPPER's and of Mr. HUNTER's time, which gave a rate so very near to CARMICHAEL's and IRWIN's: and it may not be amiss to add to these, the result of Mr. HOLFORD's; as well as the estimates of the camel's rate, formed by seven different persons. All these I have placed in one point of view, in the following table.

	CARMI- CHAE L.	IRWIN.	CAPPER.	HUNTER.	HOL- FORD.	PLAISTED.	Anony- mous.
Estimated rates	Brit.mi. 2,29	2,55	2,25	2,33	2,24	2,3	2,5
Experiments	2,475	2,48	2,51	2,585	2,5	—	—

Mean of the seven estimates, 2,35.

Mean of the five experiments, 2,51.

Mean of CARMICHAEL's and IRWIN's, 2,478.

* Mr. IRWIN also took the bearings of his course by a compass, though not so much in detail as Mr. CARMICHAEL; but Mr. IRWIN not only remarked the time, but the particular rate of travelling, on each day; which appeared to vary from 2 to 3 *per* hour, but was commonly $2\frac{1}{2}$; and the mean of all 2,55 British miles.

Before I quit the subject of the hourly rate, I shall observe, that the road distances in Mr. CARMICHAEL's traverse table are often thrown together in lines of very considerable length, such as 20 miles and upwards; and very commonly in lines of 5, 6, and 7, and yet are all considered as straight lines. By this mode, it is probable, that many small inflexions passed unnoticed: and therefore the rate taken from the results of CARMICHAEL's and IRWIN's observations, will be rather under the mark than otherwise; but it is obvious, that no kind of rule can be found to correct it by. It is certain, that fewer inflexions are likely to occur in the Desert routes, than in almost any other; not to mention that the long lines of distance happen chiefly in the open, level part of the route. The road distance exceeds the direct distance, by *one-fourteenth part* of the latter only, between Aleppo and Mesjid Ali; amounting to a fraction of $\frac{1}{14}$ British mile on each hour; or in the proportion of $7\frac{1}{4}$ miles on each hundred of direct distance. This, I confess, is much less than I could possibly have supposed; and which nothing short of actual experiment could have induced me to believe. On the whole road between Aleppo and Busforah, the proportion is nearly 11 on each hundred, on CARMICHAEL's route: but his route over the Chaldean Desert was unusually circuitous; and cannot be admitted to have any weight, in the determination of this question.

One would expect that the inflexions of which no account is taken by Mr. CARMICHAEL, would amount to at least half as much as those which are taken notice of; and such addition would make the whole hourly rate 2,56 instead of 2,475. But this is merely a supposition; and it is possible, that the rate may not be higher than 2,52, the mean of the four other experi-

ments. At all events, the error can be but small : and possibly, all circumstances taken into the case (and particularly this remarkable one, that of three persons who attempted to ascertain the rate, by counting and measuring the camel's footsteps, none reckoned it higher than $2\frac{1}{3}$, and one went so low as $2\frac{3}{4}$), I think the rate of two miles and an half *per* hour may be used, as differing but a shade from the general result ; and as having the most manageable fraction.

Thus it appears to me, that the hourly rate of the camel may be applied as a very useful scale to the African geography ; whensoever the use of watches shall be adopted by the native travellers employed by the AFRICAN ASSOCIATION * ; and with still greater advantage, of course, if Europeans are employed. And if Mr. CARMICHAEL could describe the general bearing, on a line of more than 700 British miles, so nearly as within 6 or 7 degrees of the truth ; and that with a pocket compass ; nothing more need be said concerning the advantages that may be derived from the use of that valuable instrument, aided by such a scale as I have been describing.

The mean length of the day's journey of the camel, varies according to the degree in which it is loaded : and in this particular it is that the state of the camel, as to its burthen, operates on its progress. It is necessary to observe, that whatsoever remarks I may offer, on the subject of the camel's day's journey, are meant to be applied only to the *mean* rate on journeys of considerable length ; since any other kind of experiment would be of no use in geography : I shall therefore consider only the progress of the LIGHT and HEAVY CARAVANS, in which

* In the Memoirs of ABDUL KURRIM, a Cashmerian of distinction, he informs us, that he kept an account of the time, on the road between *Bagdad* and *Mecca*, by means of an European watch, in the year 1740.

the camels are left to pursue their journey quietly and at leisure; and with the regularity of a machine: and not that of the LIGHT CAMELS, which are not only freed from incumbrance, but are also urged on.

I have two examples of the heavy kind, and three of the light kind, where the time has been regularly kept: besides a third example of the heavy kind, where the necessary regularity is wanting, but yet containing within itself, evidence sufficiently strong to corroborate the other two.

The HEAVY caravans were those of Mr. CARMICHAEL and M. HOLFORD; the first of 1000 camels, of which 600 were loaded, went, on a journey of 45 days, at a H. M. mean, each day, 7 10

The second, with 50 loaded camels, on a journey of 15 days 7 40

Mean of the two, 7 25

The third, TEIXEIRA, with 130 loaded camels, on a journey of 21 days, *about* 7 30

Mean of all, *per day*, 7 27

The LIGHT caravans were,

			H. M.
Mess. IRWIN,	} from 80 to 100 camels,	21 days,	9 12
CAPPER,		33 —	8 38
HUNTER,		34 —	8 45

Mean of the three 8 52

Here then the mean of the heavy caravan day is under seven hours and an half; and that of the light caravan between eight and three quarters, and nine hours.

Some

Some of the ordinary watering places on the Desert, being from 3 to 5 days journey asunder, it may be supposed, that the length of the intermediate journies, would be determined by the known and approved standard of a proper day's walk for a camel: for as they often arrive at the watering-place early in the day, it appears, that the caravan chiefs, do not, by any means, divide the ground between such watering places, into equal portions for marches. This being the case, one may expect to arrive at the knowledge of what is at least *intended* for a proper day's journey for a camel, under the circumstances of the case: and indeed the result is such as to prove what I have before advanced, respecting the length of the mean journies of both kinds. For having selected from the five above-mentioned journals, the length of the *apparently optional* journies in each; it appears, that the heavy caravans went 7 h. 51 m. on a mean of 24 such days: and the light caravans 9 h. 8 m. on a mean of 38 days. In both of which cases, as might have been expected, the length of the mean *optional* day, is somewhat longer than that of the whole journey; in which there is a wider field for delays and accidents. The comparison is as follows:

Heavy caravan.				Light caravan.			
Mean daily rate of the whole journey . .	H. M.	Distance in British miles.		H. M.	Distance in British miles.		
		at $2\frac{1}{2}$ per hour.	at 2,56		at $2\frac{1}{2}$ per hour.	at 2,56.	
	7 27	18,64	19,06	8 52	22,17	22,7	
Of optional days . .	7 51	19,62	20,1	9 8	22,8	23,38	

Thus

Thus the mean daily rate of the heavy caravan, appears to be 18,64 British miles, reckoning two miles and an half for each hour; and 19,06 if taken at 2,56: and the mean rate of the light caravan 22,17 miles, at $2\frac{1}{2}$; 22,7 at 2,56.

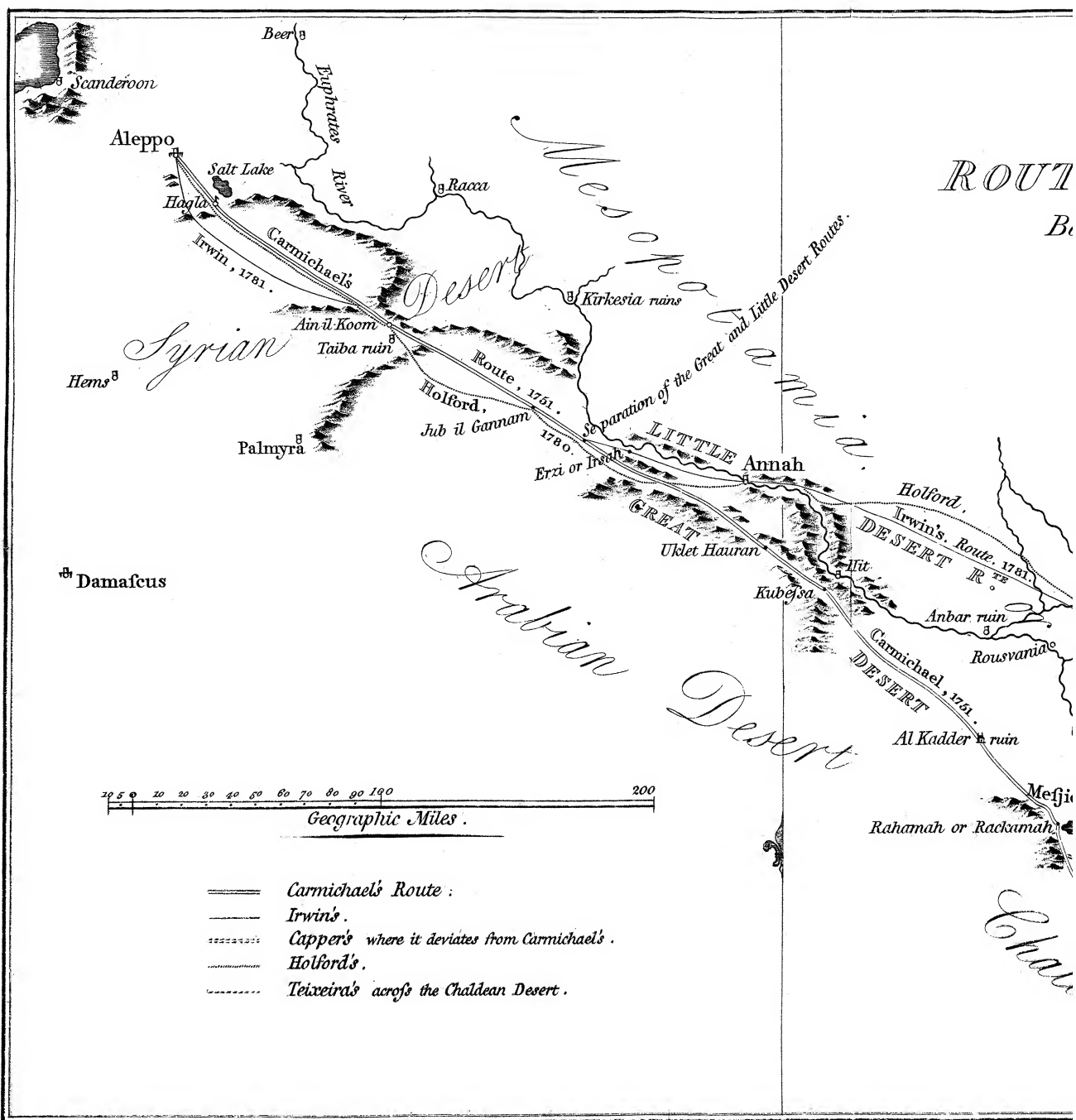
In order to apply this scale with effect, to the African geography, it is necessary to state the number of days that the caravans usually halt on the road; for as yet I have only considered their rate of motion: but it is evident, that if the length of the journey in the gross, is given, the requisite information will not be obtained, without a previous knowledge of the time lost by necessary, or unavoidable halts on the road. My enquiries have furnished me with an account of 13 halts, to 149 days of travelling; or, which is the same thing, 13 halts out of 162 days, reckoned from the time of departure, to the time of the arrival of the caravans at the place of destination: that is, 1 halt to $12\frac{1}{2}$ travelling days. This, of course, must be deducted from the aggregate of the distance: or, should it be averaged on each day, the heavy caravan day must be reckoned at 17,14 miles instead of 18,64; and that of the light caravan 20,4, instead of 22,17; when the hourly rate is taken at two miles and an half.

It also remains to be stated, from the proportion that the road distance bore to the direct distance, by the trace of Mr. CARMICHAEL's route; what length in direct distance, and in geographic miles, may be allowed for each day, for the heavy caravan, on similar lengths of journey, and over similar tracts of country. It appears then, that on the 28 days between Aleppo and Rackama (opposite Mesjid Ali) the mean length of the day's journey, in direct distance, is about $15\frac{1}{4}$ geographic miles: and on the whole 45 days between Aleppo and Bufforah, 13,8 such miles. But this is without any allow-

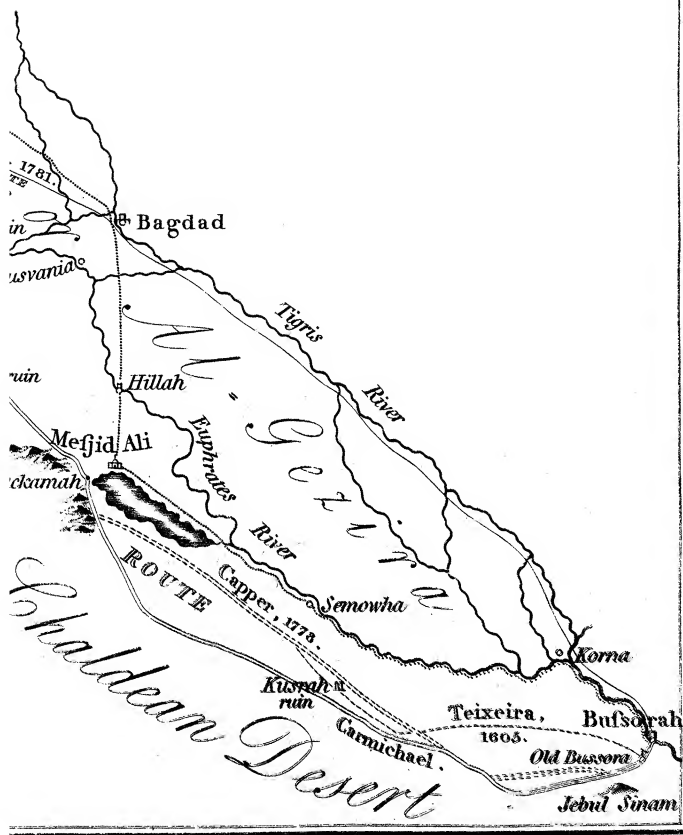
ance for halts; which, as has been observed before, require a deduction of 8 parts in 100, to be made from the gross amount of the whole journey, when applied to the purposes of geography.

I have already taken notice, that Mr. CARMICHAEL counted the camel's steps, in order to ascertain a scale of distance; and I shall now give the result of his observations, as well as of Mr. HOLFORD's, who also counted the steps, and measured the length of a number of them on the ground. Mr. HUNTER's experiment was on too small a scale to ground a calculation on. It is certain, that these reports of the number of steps during certain portions of time, and the measurement of a certain number of those steps on the ground, furnish a result that does not agree with the experiments on the great scale; such as we have just related, and which appear to be susceptible of greater accuracy than those made in detail. But it will, nevertheless, be proper to give the results, and to make some remarks on them; if be only to prevent any person in future from founding a calculation on them.

Mr. CARMICHAEL counted the double steps, or rather the return of the same foot, of a camel on which he rode, for an hour together, on 20 different days; at times when, from the nature of the ground, he thought the greatest variation took place, in the rate of motion. He found the greatest number of steps to be 2420, the least 2086; and the mean of the whole 20 hours, was 2200. Mr. HOLFORD reckoned the greatest 2240, least 2060; mean 2150. They both report the double step to be 5 feet and an half. The result of the former account is 2,29 British miles *per* hour; of the latter 2,24; and each allowed his distance accordingly, in his journal: though nothing is more certain than that their computed distances fall very short



*Sketch of the
ROUTE across the DESERTS,
Between Aleppo and Bufsorah.
1791.*



short of the truth. Mr. CARMICHAEL, for instance, reckons the distance from Aleppo to Bufforah, by the road, at 720 British miles, although the direct distance itself scarcely falls short of it. And Mr. HOLFORD's road distance also falls very short. Even Mr. CARMICHAEL's highest number of paces, would exceed the mean rate given by the experiment at large, by a *sixtieth* part only.

As these gentlemen's experiments differ only 50 steps, in the mean number, during the hour (one being 2200, the other 2150), that is, a 44th part, the error must be looked for elsewhere; and it probably originated in their measuring too small a number of steps on the ground to found their calculation on.

The reason of this great variation in the number of paces, in a given time, is the plenty or scarcity of the Desert shrubs, on which the camels feed, as they go on; and thus such experiments become almost useless, unless the quality of the Desert was described in every part. As the hourly rate of Mr. CARMICHAEL, coincides with that of Mr. IRWIN, within a very small fraction, although the one travelled in November and December, the other in March and April; it appears, that the seasons have little or no effect in this particular: and it is therefore highly probable, that the shrubs may flourish in some parts of the Desert, and be dried up in others, at one and the same season.



